TESTIMONY OF
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Good morning. My name is Alan Steinman. I am the Director of the Annis Water Resources Institute (AWRI) located in Muskegon, Michigan. The Institute is a part of Grand Valley State University. Thank you for the invitation to appear before your Subcommittee and testify with regard to restoration activities in the Great Lakes. Prior to moving to the Great Lakes region, I was involved in the restoration of the Everglades, having served as the Director of the Lake Okeechobee Restoration Program for the South Florida Water Management District. This cradle-to-grave restoration effort, which is part of the Comprehensive Everglades Restoration Plan (CERP), involved various elements including scientific research, ecological monitoring, planning, engineering, construction, real estate, and litigation. In my current position, I am involved in a variety of local and regional restoration projects dealing with some of the most pressing water resource issues facing the Great Lakes, including contaminated sediments, impacts of land use change on coastal resources, nonpoint source pollution, and invasive species. Of course, many of these problems are found throughout our country, but given the uniqueness of the Great Lakes, there is a compelling need to address them as expeditiously and judiciously as possible.

My intent today is to draw upon my experience, as well as that of others, in the on-the-ground implementation of these restoration efforts, and in so doing, address the needs and challenges facing the restoration of the Great Lakes and its basin. Most of AWRI's current projects are focused at the local level, but the principles guiding these restoration efforts are applicable to the entire region. The written testimony addresses the following topics:

- What are the essential components for a successful restoration program?
- Examples of on-the-ground restoration projects and lessons learned
- What are the needs and challenges to move forward with a comprehensive restoration effort in the Great Lakes Basin?

What are the Essential Components for a Successful Restoration Program?

Ecosystem restoration is an emerging discipline and is receiving increasing attention in scientific circles. However, successful restoration programs must address more than the science of the system, although that is clearly an essential component. Based on my experience in south Florida and the Great Lakes, successful restoration projects require, at a minimum, the following elements:

1) credible, peer-reviewed science on which to base actions
2) a holistic approach
3) public buy-in
4) long-term dedicated funding
5) adaptive management
6) evaluation and accountability

Credible, peer-reviewed science: There is often an innate distaste from funding agencies, elected officials, and the public for more "studies". Understandably, people want to see tangible action, dirt turned, and on-the-ground results. However, it is critical that these activities be predicated on scientific results that have withstood the rigors of peer-review. The up-front investment in this scientific information, assuming that the experimental design, scientific analysis, and conclusions are vetted and peer-reviewed, will pay dividends many times over in the long-run by minimizing the likelihood that ineffective or inappropriate actions will be taken.

Holistic approach: Large-scale restoration efforts often require a team of experts to successfully implement a project. For example, the Lake Okeechobee Restoration Program in south Florida requires the acquisition of thousands of acres of privately owned land to build above-ground reservoirs and constructed wetlands. Determining the best location for these construction projects requires that geologists, hydrologists, modelers, and ecologists collaborate to identify the optimum soil type, flow patterns, and biotic sensitivity. In addition, planners and engineers are needed to integrate the sites with existing infrastructure and to design the projects. Real estate experts and lawyers are needed to conduct and finalize the land transactions. Clearly, the public must be behind the project as well, or success is unlikely (see below).

Public buy-in: Ultimately, ecosystem restoration projects that do not have the approval and backing of the general public are doomed to failure. Getting public support is more than just including them in the early planning stages of a proposed project; it involves communicating with them in a language they can understand, outlining the entire restoration process, and providing honest input on both the uncertainties of success (cf. Steinman et al. 2002; Peterson et al. 2003) and the cost estimates associated with the project.

Long-term dedicated funding: Ecosystem restoration projects come in all shapes and sizes, and with varying price tags. However, large projects, which transcend multiple jurisdictions and involve many disciplines, such as in south Florida or in the Great Lakes, are expensive. To maintain momentum and sustain interest in the project, especially when projects are controversial and litigation is a threat, it is critical that the partners recognize that funding source(s) are not ephemeral.

Adaptive management: No project goes according to plan. Ecosystems are notoriously stochastic in their responses, so it is particularly important that flexibility be built into the restoration plan. Adaptive management involves assessing the data collected during the restoration process, comparing how the system is responding to the anticipated results, and fine-tuning the restoration activities to meet the restoration goals.

Evaluation and accountability: Large-scale restoration projects attract considerable attention because of their visibility, funding requirements, and need to balance competing demands for the resources at stake. It is critical that a rigorous evaluation process be established to assess the success of the project and to provide accountability to the public and scientific community at large.

Examples of On-the-Ground Restoration Projects and Lessons Learned

In order to optimize the process of ecosystem restoration, it is essential that we learn from past projects. In this section, I provide a brief overview of the restoration projects in south Florida and the Great Lakes that I have been involved with, and discuss the lessons that have been gleaned from these efforts.

The Comprehensive Everglades Restoration Plan, or CERP, is a framework and guide to restore, protect, and preserve the water resources of central and southern Florida (http://www.evergladesplan.org/). It is an ambitious plan, consisting of 68 major components, with an approximate cost of over $8 billion and a timeline of up to 30 years to fully implement. The principles behind CERP provide some important guidance when attempting to implement large-scale ecosystem restoration projects:

- A **phased approach** to implementation is important. Because large-scale restoration efforts consist of numerous components, projects will differ in scope, cost, and complexity. As the overall restoration effort moves forward in an incremental fashion, it is important to identify a few projects that can lead to quick successes, which should be celebrated, and which will help build momentum.
- It is critical to **acknowledge past and existing restoration efforts**. A large-scale ecosystem restoration project that has national visibility and federal authorization can become a juggernaut, and those people involved in its creation and growth may assume an attitude of omnipotence. This is a sure path to failure, as it will lead to alienation of partners and stakeholders. By building on the past and existing projects, there is a tacit acknowledgement that this work is valued, which helps build partnerships and generates support. This approach also makes economic sense, as it avoids redundancy and uses the available knowledge base in an efficient manner.
- Consistent with adaptive management, the **plan must be flexible**. New information, unexpected shifts in ecosystem behavior, or changes in political and economic landscapes may require refinements and mid-course corrections. It is essential that the restoration effort be structured so that these changes are as seamless and as painless as possible.

- The restoration process must maintain an **ecosystem focus**. Single-species management (e.g. for salmonids) is an easy default mode for resource managers and officials because of its intuitive appeal and relative ease of assessing restoration success. However, ecosystems are complex; approaches based on single-species management do not adequately reveal the linkages and feedbacks among individual biotic and abiotic components. Therefore, this approach often results in unintended consequences elsewhere else in the ecosystem.
- Ensure **responsible use of fiscal resources**. Large-scale restoration plans, such as CERP, and the one to emerge for the Great Lakes, must be largely conceptual in nature. This is a function of the spatial scale and complexity of these systems, combined with their multiple jurisdictions (especially in the Great Lakes with international boundaries). Detailed technical studies and designs will emerge as specific projects and elements are developed within subregions or for specific problems. Public, scientific, and governmental reviews of these studies and designs are necessary to ensure that fiscal resources are used efficiently and effectively.
- The restoration effort must be **inclusive and interdisciplinary**. Large-scale restoration plans that rely on public dollars must be open and collaborative efforts. A diverse consortium of partners involving federal and state agencies, academia, local governments, tribal participants, private industry, and the public helps to guarantee the feedback and dialogue necessary to improve the plan and to keep moving it forward. It is also essential that individuals from many disciplines be involved in the restoration process. The environmental problems facing our ecosystems are complex, and their solutions require an interdisciplinary approach involving not only scientists of different disciplines (e.g. ecologists, geologists, hydrologists, modelers, etc.) but also experts in fields as diverse as engineering, planning, real estate, law, and regulation.
- Provide **information and education** (I&E) to the public. Restoration efforts contain a considerable amount of technical information. It is critical that I&E strategies be developed and that outreach be a fundamental part of the restoration plan. The I&E strategies must be tailored toward the appropriate audience, which will help ensure informed public input.

Clearly, these guiding principles behind CERP are applicable to large-scale restoration efforts in the Great Lakes, as well. The Annis Water Resources Institute (AWRI) at Grand Valley State University has been working on a number of ecosystem restoration projects within the Great Lakes basin. Our experiences and on-the-ground work validate the importance of the above principles in the Great Lakes region, and also provide new insights.

1) One of the most problematic environmental legacies in the Great Lakes is contaminated sediments (see next section for more detail on this problem). AWRI is currently working on, or has worked on in the past, contaminated sediments in the following Michigan locations: White Lake; Muskegon Lake; Lake Macatawa; Manistee Lake, Grand River, and Little Black Creek. Both White Lake and Muskegon Lake are

designated Areas of Concern, and as such, qualify for funding from the Great Lakes Legacy Act.

However, the number of designated contaminated sites in the Great Lakes Basin exceeds the number of Areas of Concern by an order of magnitude—as a consequence, hundreds of contaminated sites do **not** qualify for funding under the Great Lakes Legacy Act. For example, Little Black Creek in Muskegon County, MI flows directly through the municipality of Muskegon Heights, a largely African-American, economically disadvantaged community. Children play in this creek on public park land, despite some of the highest cadmium levels measured in the entire Great Lakes region (940 mg/kg; Steinman et al. 2003). In addition, most of our samples had concentrations of cadmium, chromium, lead, PAH (polycyclic aromatic hydrocarbon compounds), benzo(a)pyrene, and PCBs that exceed the standards generally applied for the protection of aquatic life (cf. MacDonald et al. 2000). Perhaps most disturbingly, concentrations of lead, benzo(a)pyrene, cadmium, and PCBs were at levels that exceed human health criteria for long term direct contact. Technically, restoration of this creek would not be particularly difficult; the technology and knowledge are available. However, the social and economic barriers are formidable. Despite concerted attempts to engage the community, only limited progress has been made. Clearly, a more effective I&E strategy is needed. In addition, because Little Black Creek is not a designated Area of Concern (although a large part of the contamination originates from a Superfund site), it does not qualify for Great Lakes Legacy Act funding. There are many "Little Black Creeks" throughout the Great Lakes region, all in need of effective outreach, public involvement, and adequate funding for ecosystem restoration.

2) Surface water runoff, and its associated pollutants, is a problem in many of the freshwater ecosystems across the nation. The Great Lakes region is no exception. Nonpoint sources of pollution, such as runoff from lawns and streets, cause more pollution than point sources in the United States (Carpenter et al. 1998). Exacerbating this problem is urban sprawl, the efflux of people out of urban areas to rural regions, especially along the Great Lakes coastal reaches (see next section for more detail on this problem). AWRI is currently working on a number of watershed assessments and management plans in west Michigan, partnering with private and public sector entities, and using our expertise in GIS (geographic information systems) technology, nutrient chemistry, modeling, and ecological science to characterize the nature of the problem, recommend science-based solutions, and implement restoration activities where appropriate.

The Muskegon River Watershed is the second largest in the state of Michigan and covers approximately 2725 mi^2 (7078 km^2). Two of the major stressors in this watershed are excessive nutrient loading and thermal pollution, both of which threaten the warm and cold-water fisheries and other aquatic life in the system (U'Ren 2002). A comprehensive watershed management plan has been produced by AWRI (U'Ren 2002), which includes a number of recommendations to help reduce the impacts of these stressors and restore ecosystem structure and function in this watershed, including (1) the development of a Muskegon River Watershed I&E strategy by the Muskegon Conservation District, which lists the key target audiences, and how to develop and distribute effective messages to these audiences; (2) the identification of critical areas in the watershed---AWRI used GIS to identify those areas most sensitive to environmental stress, as determined by in-stream temperature fluctuation, surface water runoff, and percent of developed land use (agriculture and urban); and (3) the designation and implementation of best management practices (BMPs) that are tailored to the specific needs of individual sites.

For watershed restoration projects in the Great Lakes, such as the Muskegon River Watershed, to have success in the long-run, it is clear that certain elements must be in place. First, GIS technology must be utilized to synthesize the geographic, green infrastructure, and grey infrastructure information available in order to identify critical regions with the watershed. Second, on-the-ground inventories are necessary to select the optimal sites for BMP implementation. Third, sound science is needed to reduce the uncertainty associated with management decisions and to establish cause and effect relationships between environmental stressors/pollutants and societal values in the watershed. Fourth, a defensible monitoring program must be implemented to establish baseline conditions and to assess the effectiveness of restoration efforts. Finally, information, education, and outreach activities must be initiated and sustained throughout the watershed.

What are the needs and challenges to move forward with a restoration effort in the Great Lakes Basin?

Although the Everglades restoration plan provides an important and useful example for undertaking large-scale ecosystem restoration projects, there are fundamental differences in the needs and challenges facing restoration efforts in the Great Lakes compared to a system such as the Florida Everglades. The Everglades restoration involves only one state and focuses primarily on the hydrology of the ecosystem. In contrast, ecosystem restoration in the Great Lakes involves two provinces, eight states, multiple tribes, and must focus on numerous stressors. Hence, the needs and challenges for developing and implementing an effective and comprehensive Great Lakes Ecosystem Restoration Plan are significant.

A considerable amount of literature is devoted annually to the status of the Great Lakes, and there is no need to repeat it here. Arguably, the major threats to the Great Lakes ecosystem include the following:

- Invasive species
- Contaminated sediments
- Water quality
- Water quantity
- Land use change
- Climate change

Below, I briefly discuss each of these threats.

Invasive Species: In aquatic ecosystems, the Great Lakes have served as the poster child for invasive species (Ricciardi and MacIsaac 2000, Vanderploeg et al. 2002); impacts include habitat loss, food chain disruption, and alterations to native fisheries. It is now estimated that since the 1800s, approximately 170 species have invaded the Great Lakes ecosystem. The economic costs are staggering, with estimates of ~$10 million per year being spent on sea lamprey control, and ~$100 to $400 million per year for zebra mussel control and mitigation in the Great Lakes basin.

Contaminated Sediments: Both lake and river sediments throughout the Great Lakes are contaminated with toxic metals and organic chemicals. Polluted sediments are the largest major source of contaminants to the Great Lakes food chain, and over 97% (8,325 km) of the shoreline is considered impaired (USEPA 1999). The Region V sediment inventory contains 346 contaminated sediment sites. Contaminated sediments result in restrictions and delays in the dredging of navigable waterways because they have to be placed in some form of confined disposal facility. This has obvious negative implications for local and regional economies. Of the ~ 15 million cubic meters of sediments dredged for navigational purposes from 1990 – 1995 in the Great Lakes region, 51% had to be placed in some form of confined disposal facility due to high contaminant levels.

Water Quality: Although the Clean Water Act had a dramatic impact on reducing the cultural eutrophication of the Great Lakes and its connecting waters, water quality impairment is still a problem in the region. In particular, agricultural runoff (from row crop and pasture fields), stormwater runoff (from residential and urban areas), commercial fertilizer applications, and runoff from animal waste (from agricultural, natural, and residential sources) contribute to the water quality problems in the region. Land use changes (see below) potentially exacerbate impaired water quality.

Water Quantity: The Great Lakes cover about 95,000 mi^2 and supply ~18% of the planet's surface freshwater and ~90% of the U.S. surface freshwater. Despite this apparent abundance of freshwater, water quantity is an issue in certain regions of the Great Lakes basin. Groundwater withdrawals are resulting in potential ecological impacts due to surface-groundwater connections (cf. Steinman et al. 2004).

Studies by the United States Geological Survey in southeastern Wisconsin confirm the implications of groundwater withdrawal (http://wi.water.usgs.gov/glpf/index.htm). Groundwater that once flowed toward Lake Michigan is now intercepted by pumping and diverted west, toward the Mississippi River Basin. Thus, compared to predevelopment, pumping in this area has reduced the amount of groundwater that flows directly to Lake Michigan across the coastline or that flows indirectly to it as part of river discharge. Some of this diverted water is eventually returned to the Lake through sewers and water-treatment plants, but the location, timing, and quality of the return flow is different than what it was under natural conditions, which can have profound ecological implications (cf. Baron et al. 2002). Given the overall hydrologic budget for Lake Michigan, the absolute reduction in lake-bound groundwater discharge due to pumping is very small. However, it may have serious implications for the local ecology and economy.

Land Use Change: Changing land use patterns are having a dramatic impact on the natural resources in the Great Lakes region. This is particularly true along the Great Lakes coastlines, where the natural beauty of the lakeshore is attracting more and more people. The land cover/land use changes in the Mona Lake Watershed, a small watershed (48,000 acres) in west Michigan that drains directly to Lake Michigan, is representative of many of the trends seen throughout the Great Lakes basin: between 1978 and 1998, there have been increases in residential, commercial, and open field coverages, and declines in the amount of cropland, pasture, and forest; Steinman et al. 2003). As urban sprawl grows throughout the region, increased pressures are being placed on aquatic ecosystems because of more impervious surfaces, the draining or filling of wetlands, more withdrawal of groundwater supplies, and greater density of septage systems.

This problem has been recognized in the state of Michigan. A bipartisan Land Use Leadership Council was formed in 2003 to minimize the negative impacts of current and projected land use patterns on the state's economy and environment. The final report identified more than 160 recommendations (final report available at http://www.michiganlanduse.org/finalreport.htm).

Climate Change: A recent report (Kling et al. 2003) notes that available data strongly indicate the climate of the Great Lakes region already is changing: winters are getting shorter in duration; annual average air temperatures are increasing; duration of lake ice cover is declining; and heavy rainstorms are becoming more common. Climate models predict that by the end of the 21st century, winter temperatures will increase by 5 to 12°F (3 to 7°C) in winter, and by 5 to 20°F (3 to 11°C) in summer. If model predictions are accurate, this means that a Michigan summer today will feel equivalent to what summer currently is like in Arkansas. These climate-induced environmental impacts influence the economic, social, and human health sectors, as well (Kling et al. 2003).

Needs and Challenges: Each of the six threats described above has a unique set of needs and challenges. A comprehensive restoration plan would address each of them, and any others that should be included, through an appropriate vetting process that includes the appropriate experts and public input. However, there are common needs and challenges that bind each of these threats:

Needs:

- A comprehensive, coordinated monitoring plan that addresses the major stressors to the Great Lakes, and which will be used both to establish and refine baseline conditions and to assess future trends
- Effective information and education strategies that engage all sectors of the public in the restoration process
- Funding: this will be an expensive process, and it must be based on a long-term, dedicated funding stream

Challenges:

- Avoidance of turf battles: given the number of parties already established in the region, it will be a tremendous challenge to foster a cooperative, collaborative environment
- Knowledge management: there is a wealth of information currently being generated in the Great Lakes basin. Much of it is coordinated, but much of it is not. Major challenges associated with this issue include (1) prioritizing what information is most essential for the restoration effort (conceptual models can help kick-start this process); (2) developing and implementing the appropriate database management system; and (3) maintaining and updating the database.
- Finding and maintaining the necessary funds

Summary

The Great Lakes ecosystem provides an enormous number of services and functions to the region. It is currently facing a variety of stresses and pressures, which should be addressed through a comprehensive, coordinated ecosystem restoration plan. Although ecosystem restoration is still far from being an exact science, there are certain elements whose inclusion are strongly recommended in order to ensure the greatest chance of success. These include involving the public in a substantive way, basing restoration activities on sound science, being inclusive during plan development and implementation, retaining a flexible approach, and building accountability into the process.

I hope that the examples and lessons learned presented here, which are based on my personal experience and that of many other dedicated people, will help place this issue in a broader and more pragmatic context, and be of use to you and the committee. Thank you again for the invitation to appear today.

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